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DSTO

Use of Simulation in Maritime Operations and Training

D.D. Richardson

DEPARTMENT OF DEFENCE

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

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ABSTRACT

A review was undertaken of the needs within the Royal Australian Navy for simulation and simulators. These are being used increasingly for a wide variety of purposes, or are being considered for use. A summary of the interest within Navy on the subject is presented. In addition, an assessment has been made of those aspects in which Maritime Operations Division could provide a contribution, either through assessment, modification, or development of simulations. A list of recommendations for the way ahead for MOD activities in this area is provided.

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Use of Simulation in Maritime Operations and Training

Executive Summary

In response to recent requests from Navy for DSTO to provide more support in the area of simulation, a review of the requirements of Navy in this area was undertaken, vis-a-vis the capabilities and potential development of skills in MOD. This was done to assess and then recommend what effort MOD should be allocating to simulation R&D. A comprehensive assessment of Navy's interest in the area was made and is reported here. This has been related to MOD future trends and recommendations are made on how MOD can respond to the Navy request.

Navy's main requirement at present is to develop further its use of simulation for training at all levels. This has taken on greater focus with the formation of Navy Training Command and its elevation to two star level. In addition, there is increasing demand for simulations to support equipment acquisition, to assist in the development of tactics, and in a number of other areas.

MOD has for some time been supporting simulation by the development of models and algorithms for tactical support, operational assessment and a range of other Navy activities. MOD also holds considerable expertise in modelling the effects of the environment on Naval operations. These areas of expertise indicate that the most effective way that MOD can support simulation is by their application to the simulation problems that arise in Navy.

Issues concerning hardware and simulation systems design are addressed elsewhere in DSTO, particularly by Air Operations Division. MOD may occasionally play a liaison role between these Division and Navy, as required. Command and Control simulations were until recently studied, to the extent that they helped examine the interoperability of systems, by Information Technology Division. This is an area that MOD needs to pick up since it is central to the operations aspect of Navy work.

MOD should also avoid those aspects of simulation and simulators that are presently satisfactorily undertaken by private enterprise.

Contents

1. RECOMMENDATIONS 1

2. SUMMARY 2

3. BACKGROUND 3
   - 3.1 Definition 3
   - 3.2 Modus Operandi 3
   - 3.3 MOD Related Skills 4
   - 3.4 Uses of Simulation 5
   - 3.5 Navy Training 6
   - 3.6 Naval Scientific Adviser Study 7
   - 3.7 Distributed Interactive Simulation 7

4. INFORMATION FROM OTHER ORGANISATIONS 8
   - 4.1 Air Operations Division 8
   - 4.2 Information Technology Division 9
   - 4.3 DNMOP 9
   - 4.4 Naval Training Command 9
   - 4.5 HMAS Watson - RANSWARS 10
   - 4.6 Warfare Systems Centres 13
   - 4.7 Naval Warfare Training Centre (Project SEA 1412) 13
   - 4.8 On Board Trainer System (Project SEA 1641) 14
   - 4.9 Anzac Ship 15
   - 4.10 Military Strategy and Concepts, HQADF 16
   - 4.11 NSA Review 17

5. OVERSEAS TRENDS 17

6. RECOMMENDATIONS FOR MOD 18

7. ACKNOWLEDGEMENTS 19

8. BIBLIOGRAPHY 20

1. Recommendations

(a) Support establishment of an ADF-wide Simulation Support Committee to standardise simulator protocols

(b) Assist Navy to develop a policy on simulators

(c) Start with simpler problems - e.g. engine control panel, Gunnery trainer

(d) Undertake an OR-based study of the current use of simulators at HMAS Watson - effectiveness of use, new ways, better methods, deficiencies, areas for new simulators, etc

(e) Possible tasking to start with might be a type 4 task in 93/94 to examine the feasibility of Navy developing a gunnery simulator, and/or a task to develop mix-and-match performance models for naval surface ships.

(f) Use expertise currently residing in OR, MWO areas to manage simulation studies, but draw on any suitable MOD staff

(g) Eventually assist Navy to develop plans to use DIS to link simulators via Project 1412. AOD have expertise in this area, and should manage DSTO's effort on DIS.

(h) Navy require a simulator systems design & specifications capability in hardware, firmware and software. MOD should avoid undertaking any aspect of this which can be undertaken by industry, or which AOD already does.

(i) Other Divisions have expertise to draw on, especially AOD and ITD and this should be used whenever possible. Hardware and man-in-the-loop studies should be done by AOD; Command and Control studies should be done by ITD, where they relate to systems hardware and interoperability

(j) Where MOD cannot provide the service on simulation itself to Navy, it should act as the conduit to other parts of DSTO, where desirable

(k) Concentrate on the use of simulators for training. This is where the initial need is greatest. Other areas (eg wargaming, tactics studies) may require more effort later on.

(l) Have a single Research Leader responsible for simulator tasking (perhaps either RLMOR or RLMW)

(m) Develop strong ties with the new Naval Training Command (RADM Briggs) and explore/advise on ways that MOD can help develop training capabilities

(n) Assign additional staff specifically for research on simulation. However, the emphasis should be on practical application, and not on simulation technologies per se.

Eventual Aim

That MOD become known as advisers to RAN on simulators and their uses and usage, in particular through support in the areas of tactics, environmental effects, model and algorithm development.

2. Summary

In response to recent requests from Navy for DSTO to provide more support in the area of simulation, a review of the requirements of Navy in this area was undertaken, vis-a-vis the capabilities and potential development of skills in MOD. This was done to assess and then recommend what effort MOD should be allocating to simulation R&D. A comprehensive assessment of Navy's interest in the area was made and is reported here. This has been related to MOD future trends and recommendations are made on how MOD can respond to the Navy request.

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MOD has for some time been supporting simulation by the development of models and algorithms for tactical support, operational assessment and a range of other Navy activities. MOD also holds considerable expertise in modelling the effects of the environment on Naval operations. These areas of expertise indicate that the most effective way that MOD can support simulation is by their application to the simulation problems that arise in Navy.

Issues concerning hardware and simulation systems design are addressed elsewhere in DSTO, particularly by Air Operations Division. MOD may occasionally play a liaison role between these Division and Navy, as required. Command and Control simulations were until recently studied, to the extent that they helped examine the interoperability of systems, by Information Technology Division. This is an area that MOD needs to pick up since it is central to the operations aspect of Navy work.

MOD should also avoid those aspects of simulation and simulators that are presently satisfactorily undertaken by private enterprise.

3. Background

This Review arose from a stated requirement by Navy that DSTO provide more support for its requirements in simulation. As a result, the author was requested by A/CMOD to examine -

- what support might be provided by Maritime Operations Division,
- the skills and the numbers of personnel required, and
- which parts of the current MOD structure should contribute.

The current RAN interest in simulation arises from training issues alone (though it is intended to broaden the use of simulation to other applications). The cost of so-called live-training (particularly at sea) is rising, and the availability of training billets is expected to decline over the next decade. This is due to expected de-commissioning of the Destroyer Escorts, and of HMAS Jervis Bay, though these are partly compensated by the likely acquisition of a substitute for the helicopter support ship and a number of other possible procurements (eg Offshore Patrol Craft, USN FFG(s), etc).

3.1 Definition

Simulation means different things to different people. For the purposes of this study, simulation is defined as [24]:

> Simulation is the use of artificial representations of real situations and equipment in order to provide the user with equivalent experiences to those gained from the use of the real situations and equipment.

For this study, simulation *does not* include computer aided learning, but *does* include the use of formal simulators such as the Bridge Simulator and combat systems simulators, as well as wargames.

3.2 Modus Operandi

The review undertook to examine what expertise currently exists within DSTO to undertake simulation support to the RAN, and what the actual requirements are with Navy for support for simulation. This was done by attendance at DSTO sponsored simulation meetings and courses, by discussions with personnel within DSTO, by interviews with RAN officers with an interest in simulation, and by examining current RAN simulation facilities.

The most overt expertise in simulation in DSTO currently resides with Air Operations Division at Fisherman's Bend [6], [10], [11]. The responsible Research Leader, Dr Bob Feik, is managing a significant program of work to increase the facilities for simulation at ARL. This includes purchase of a number of simulators for a range of uses. It also includes the development of artificial intelligence methods for air

combat modelling and simulation. Also under study is a method of linking simulators, based on the USA Distributed Information System approach.

A smaller effort is also being undertaken at ITD Salisbury (and Canberra) where emphasis centres on Command and Control systems and their interoperability.

Interest within the RAN has come from a number of quarters. There is no Navy policy on simulation at present, though NSA's office (Steele, Mathias) has been tasked with proposing such a policy, and has undertaken a parallel study to this MOD one.

DCNS is known to support increased coordination and use of simulation in Navy. Others who are also known to have views include

- DNMOP, Capt Mark Proctor
- Naval Training Commander, CDRE Peter Briggs (now RADM Briggs)
- DRANSWARS, Capt Stapleton
- MWSCPD, Cmdr Mike Welford
- CMDR Greg Yorke, Anzac Ship Project
- LCDR Mike Spruce, DCFD(Sea)

Various officers within these commands have also contributed a range of views.

3.3 MOD Related Skills

The skills required for simulation support are multi-disciplinary. They include areas such as applied mathematics - numerical analysis/modelling and algorithm design, physical modelling, computer systems and architecture design and analysis, database design and use, learning psychology, operations research, trials analysis, user interface design, and general human factors research.

Hence, many areas of MOD could potentially contribute. In particular, though, it is felt that at least to begin with, the greatest contributions might come from the computer modelling areas currently addressing mine countermeasures, and the operations research area.

MOD already undertakes de facto simulation studies in a wide range of areas. In Mine Warfare, mine hunting, mine sweeping and clearance diving simulations have been developed. Simulators of a number of aspects of sonar sensing have also been developed, as well as wide ranging studies of combat systems.

3.4 Uses of Simulation

Simulation can be used to serve a wide range of functions. These include [24]

1. Basic training
2. Expert training
3. Command and Control training
4. Equipment evaluation
5. New equipment assessment prior to specification/development
6. Operational planning
7. Operational analysis
8. Tactics development
9. Strategic analysis.

The RAN currently use simulation primarily for training.

There are generically two forms of training simulation - for initial or basic training of previously unskilled people, and for the honing of the skills of experts in an area. The first class would cover new recruit training, and training for junior officers, eg in watchkeeping. Examples of the second class include improving the skills of gunnery officers, and the training of combat systems officers in air defence. The latter class is often directed towards tactics development or refinement, while the first class is intended to teach procedures.

The use to which simulation is put determines the nature of the simulation itself. For example, initial training needs to show great detail so that the student can get a grasp of the concept, and so he will feel comfortable when faced with the real environment. On the other hand, expertise training often does not require such great realism, but rather concentrates on providing challenges for the student, based on his existing knowledge.

Training also can be divided into two other categories which cut across the above. It can be done on an individual, or a team basis. Though distinct from basic and expert training, there is a relationship, since basic training tends to require individual instruction and development of skills, while expert training can sometimes (not always) involve training as a team.

Simulators have a number of inherent limitations. These include

- Limitations on the physical stimuli provided to the student (eg lack of motion, sound, smell),
- Limited scope of experiences provided (only those situations programmed in can be experienced),
- Lack of visual fidelity - so that scenes, etc portrayed will only approximate the real view (eg display of a control panel on a screen, instead of using the actual panel),

- Knowledge by the student that it is only a simulation, leading to reduced levels of stress, an inclination to take less seriously, etc.

- Limitations on the representation of the effects of the real environment on sensors, FCS, communications, etc (reverberation, clutter, noise, false targets, etc).

- Does not generally meet "maintenance" training requirements.

Simulation is seen by Navy as a way to maximise the effectiveness of sea time training, and to provide trainees with a range of experiences which they would not otherwise get (eg missile firing from FFGs and DDGs). It also provides a technology for keeping up with new equipment acquisitions while not requiring or having the same equipment available for training, eg the Mk 92 gun for the Anzac Ship. This is done by simulation of the equipment, rather than by training on the equipment itself. Changes to equipment can be accounted for by changes to software in the simulator.

3.5 Navy Training

This has recently (1 July 1993) been integrated into Naval Training Command under CDRE Peter Briggs [8], [9]. More recently, CDRE Briggs has been promoted to RADM, and is now known as FONT - Flag Officer Naval Training Command. This is a strong indication of the increasing importance that Navy is placing on training.

In fact, it has been found that over 10% of Navy time is spent on training. At least three times that of either the Army or Air Force, is spent sending trainees overseas.

Training for the RAN is divided into two parts - individual training, and collective training. The individual training could also be described as initial or basic training, while collective training covers advanced and team training.

Individual training is intended for the basic education of people who have not been trained in the particular area previously. On the other hand, collective training is intended for those who have completed individual training, are generally exposed to the operational environment, and who need to have their skills honed in a working team environment. Collective training is therefore a form of expert training.

Also of increasing interest in Navy is Computer Based Training [14]. This has several definitions, but essentially means making use of computer displays and software to train individuals. For example, HMAS Watson are developing a CBT system for training operators of the SQS56 FFG sonar, and the Electronics Warfare School at HMAS Cerberus are developing CBT systems for fault finding in electronic circuits. In general, CBTs are developed to emulate a single piece of equipment or control panel, may have touch screen input, and can either be pre-programmed to simulate a range of faults and conditions, or be linked to a computer controlled by an instructor for his intervention.

CBTs have the advantages that they are low cost relative to the actual equipment, can be taken and used at any location (including at sea), and can be readily re-programmed. They are generally installed in a general purpose computer such as an IBM PC or compatible. There is a high initial cost for CBT, though. It was claimed at NTC that it took 100 hrs of work to develop one hour of CBT aid.

It was estimated by Capt Horton, that basic training takes up about 2/3 of all training (about 2000 personnel at any time), and expert training takes up the remaining 1/3 (mostly team training).

3.6 Naval Scientific Adviser Study

Simultaneously with the current MOD review, NSA's office has been examining the wider issues of what policy Navy should adopt with respect to simulation, and in particular, what DSTO as a whole (not just MOD) can provide in support of this policy.

3.7 Distributed Interactive Simulation

This is a system which is being developed in the USA [7], [24] to enable a wide range of simulators to communicate. DIS began within the US Army, but has now spread across all three services. The USN now regularly participate in DIS-based exercises [20]. It allows people operating these simulators to play against each other, rather than against a computer model of the other aspects of the game.

The technology to achieve this is quite complex, and includes database designs, as well as communications protocols and the use of dead reckoning in each simulator to update the game status between information exchanges with the central host computer.

This technology is of particular interest to RANSWARS at HMAS Watson, who see it as a means to improve the realism of the use of simulation for team training, particularly for combat training. It would allow operations room players to pit their skills, for example, against an Air Force pilot flying an F/A-18 simulator, and another flying a P3C, as well as against operators on other naval vessels or their simulators. This would be much more realistic than playing against pre-programmed computer generated tactics. It would also allow for on board training of crews, playing against other assets at sea and ashore. This would permit greater flexibility for training than is currently possible. By the use of simulation for threat assets, such as aeroplanes and surface vessels, more realistic threat situations (including greater numbers of opposition forces) could be created at considerably lower cost than that of providing real threat platforms.

4. Information From Other Organisations

4.1 Air Operations Division, AMRL

Air Operations Division at Fishermens Bend, AMRL have recently established an Air Operations Simulation Centre [6], [11]. The major components comprise

- distributed real-time simulation environment
- scenario generation software and threat environment
- database management software
- generic single and two place reconfigurable cockpits
- reconfigurable team stations
- airborne (back end) and ground based operator stations
- image generation and visual display systems, including helmet mounted display and partial dome
- extensive data management, recording, replay and analysis capability.

Equipment incorporated into the AOSC, or planned to be, includes [6]

- Single seat cockpit
- secondary image generator
- avionics concepts laboratory
- programmable cockpit
- convolvotron
- primary image generator
- helmet mounted display
- partial dome display system.

The last three items are soon to be installed.

Though intended for simulation of a range of air operations, the skills residing at AOD, and some of the software and equipment are suitable for application to RAN simulation problems.

The emphasis on simulation research for Air Force appears to be somewhat different from that required by Navy. It concentrates on human performance and individual advanced trainers. Navy's requirement is much broader, covering the whole gamut of training for all ranks and levels of experience. Therefore, while the knowledge of the researchers at AOSC will be extremely valuable for Navy, it is expected that a broader scope of expertise and skill will be required in order to fully address Navy's need, compared to that of the RAAF.

4.2 Information Technology Division

CITD, Don Sinnott indicated that ITD are doing work mainly on Command and Control simulation under Max Possingham. They are stopping, or have already stopped, work on weapons systems simulation.

Max Possingham is doing C^3I simulation for Army, as part of Janus, as well as Eadsim (Air Defence Simulation) for Air Force. (AOD work on Eadsim, too.)

Geoff Schapel is looking at interoperability problems in Command & Control [13]. This work is done for MHQ, but is part of a TTCP collaboration under the AusCanNZUKUS agreement. (The study is divided into two committees - Naval Communications, and C&C.) Use is being made of the NRAD (Naval Research & Development, Test & Evaluation Division), San Diego wargames and the UK NISAS (Naval Information Systems Architecture Study) simulation models.

None of the work directly involves working on simulation, though they do access wargames in the US, UK.

4.3 DNMOP

CAPT Mark Proctor, DNMOP, was interviewed at MHQ. The range and scope of Navy's requirements for simulation was discussed at length. This included discussion on the use of stimulators on board the fleet ships, as well as the desirability of using communications between vessels, and between vessels and shore installations, in order to improve the capability for team training by allowing players in different locations to play against each other, in a manner reminiscent of the USA's Distributed Interactive Simulation system. In this regard, SEA 1412 (see sections 4.5 and 4.7, below) was mentioned.

4.4 Naval Training Command

Navy Training Command [8], [9], under the command of CDRE Peter Briggs (now RADM Briggs), has the greatest requirement for simulation support. CDRE Briggs and his Executive Officer, CAPT David Horton, were interviewed at HMAS Cerberus.

The Warfare, Electronics and Engineering Schools at HMAS Cerberus were also inspected, and CMDRs Marsden and Stapley, who head the schools, were interviewed.

CAPT Horton and others suggested that MOD should start by selecting a single problem to work on, and if that is successful, to then consider expanding the research base. The project suggested was to develop a gunnery range simulator to substantially replace the West Head facility. This would provide by simulation, much of the experience currently provided by live firing on the 4.5" and 76 mm guns at West Head. It could also provide training on missile firing, which is presently poorly catered for, as

missile firings are rare, and no simulator currently exists. [Industry should do the simulation work - they have the capability. MOD should consult and provide details of the physics to be used, etc.]

The main issue of concern to NTC with any training method is its cost effectiveness. NTC also need work done to determine what simulation is needed in training.

NTC currently spend a significant fraction of their budget sending people to the Naval Training Systems Centre at Orlando, FL, and to study at the University of Florida at Orlando.

CMDR Stapley also suggested that an engine control panel could be a good candidate for simulation, and showed us the present configuration which uses a Fremantle Class engine and control panel. Such a simulator could model both diesel engines and also the existing (and possibly new) range of steam propulsion systems. [This work can be done commercially and there is no clear reason why MOD should get involved.]

CMDRs Marsden and Stapley also mentioned their interest in computer aided learning, for off-site training for WEOs, etc.

4.5 HMAS Watson - RANSWARS

Two visits were made to HMAS Watson. The first visit was made to interview CMDR Goldrick, LCDR Gordon Burns and CMDR Les Goodridge, on the Navy's use of simulators for combat systems training. The existing facilities were examined. Also located at HMAS Watson is the Bridge Simulator and the Submarine Warfare Systems Centre, which makes extensive use of simulators for training.

Much of the training at Watson is expert training in procedures or tactics, and usually involves team exercises, rather than individual training.

The current Argus (Action Information Operations Tactical Trainer - AIOTT) trainer is 18 years old and no longer supportable. Serco maintain the building and the facilities, at present. A new trainer - OTTF - project SEA 1230, Operations Team Training Facility, costing $20m is to be installed in Dec 93-Jan 94. The OTTF is claimed to use emulation rather than simulation, as it is cheaper. OTTF can handle two crews at once, and will model DDG Ops room, and FFGs, plus access cubicles to account for a further 5-6 ships.

An Anzac Frigate Ops Room simulator (Mil Spec Ops Room Model) is to be installed in 1995 (see section 4.9). It can't handle multi-ship training, and can't talk to OTTF, though the plan is to enable this at some stage. The latter is planned through the Maritime Warfare Training Centre Project 1412 (sponsor DCFD(Sea), Capt Nye), section 4.7, below.

(SEA 1412 phase 1 involves getting the FFG models communicating with the Anzac Models - for 1994-5; phase 2 is for a DIS link to all simulators - ops room, ships, P3,

SWSC, Seahawk, F111, F-18 simulators - for 1996-97 or later.) RANSWARS state that they are capable of supervising the operation of the outcomes of 1412. They believe that it should be done ADF-wide, not just single service.

They envisage an integrated system including an integrated range combined with live assets and simulators, and used for training, operational firings, and conceptual development (tactics). Simulation could be used particularly to multiply the force strength of the opposition. Such an approach could improve the sophistication of procedural training.

There is a need to make both the Anzac simulator and OTTF DIS compatible (ie use the defined data formats and communications standards), though at present no attempt has been made to account for this in the projects. This has been discussed with ARL personnel.

RANSWARS have five in-house software developers, and the trend is towards increasing interest in the activities of the TTCP Virtual Reality Working Group (in Subgroup U, with ARL).

RANSWARS stated a need for wargaming support from MOD, particularly for command-level models, LCDR to RADM, in both surface and sub-surface warfare. This would cover single service tactics at XO, CO and flotilla levels. They are also interested in exploring how they should use DIS when they get it.

Simulation should be used to increase the level of training to improve the quality of the use of sea time, thus reducing tuning and setup times. Simulation cannot substitute for sea training, but it can minimise it. The current approach is that simulation should *not* change the way in which people are trained.

At a later date, HMAS Watson was re-visited to examine more closely the use of simulators in a training exercise. Our hosts were Capt Jim Stapleton, CO HMAS Watson, and CMDR Les Goodridge, Base Engineering Officer. It was stated that RANSWARS undertakes procedure training, tactical training, and tactics development [3].

It was felt that there is a need to tailor the type of simulation to the levels of training required.

All simulators must talk the same language - ships alongside, at sea, Nowra, Williamtown, etc - make provision for communications. There exists a need for a cross-service interest group - to ensure standardisation. There is a Naval Training Quality Council under RADM Briggs, to coordinate training development. [Note however, that for simulation, the issues are wider than just training.]

On new projects relevant to RANSWARS, the following comments were made. They felt that Project 1412 should now be called Maritime Warfare Training Centre, not

Naval Warfare Training Centre.[1] It should be open to all services to participate and contribute. The On Board Training System Project will need to provide an interface between ships to make the link. RANSWARS will need to be able to prepare a threat package for ships to take to sea.

MOD might be able to help on an OR-related issue. This is how RAN train using simulators and how their use might be improved. They want a more objective assessment of effectiveness of simulation, and an objective evaluation of individual's performance. Also, can simulation systems be used in new ways?

For example, at present there is no way to display a small radar cross section target, and they don't know what a 1 m^2 (missile) object looks like on the display. MOD could assist in determining how to set their systems up to do it, eg for the SBS 40/52 radar (FFG). They feel that they need an analysis capability for such things.

A tour of the bridge simulator was made The bridge simulator was presented as intended for operator training (mainly navigation). It saves steaming time. It forms an important part of the Officer of the Watch training.

The Action Information Tactical Trainer - command team and PWO trainer - AIOTT - Argus - is going in December 93. The replacement IOTTF - DDG Command team trainer ops room handover is due for February 1994. How good it will be is unknown as it is supplied by one of the projects and Watson had little to do with the specs for it. An FFG Ops room will be included 1 year later. They will later change the DDG room to one for the FFG. The Anzac Project will provide a Command Team Trainer only. It is NOT designed for PWO training and does not have cubicles for other assets. All software will be in Ada, with a VME architecture.

Eddie Hanham (works with Les, HSD-M, 337-0385) says that ARL (AOD) are getting more serious about DIS.

The Aircraft Control Trainer was viewed (Leut Bill Thorpe). It is only a few weeks old. They are still learning how to use it.

Serco have a contract to maintain the Tactical Trainers, and also are paid to develop Computer Based Training aids (CBTs). Examples of work done or underway include FFG SGS56 sonar display, an ESM trainer, and a Rules of the Road trainer. The trend is to on-board simulation.

It was suggested that MOD could help define what skills should be taught with a simulator.

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[1]MWTC (Proj 1412 - NWTC) to link simulators; Phase 1 PDS; Phase 2 OTTC link to Anzac via DIS (ARL have a 40 min video on DIS); Phase 3 Seahawk, P3C, F18, F111, FFG OBT (on board trainer) (IMRAD stimulators for FFGs), SWSC (Collins), JORN, MWSC, and possibly others.

4.6 Warfare Systems Centres

The Navy has a number of Warfare Systems Centres, including the SWSC, AWSC and the MWSC. All make use of simulation, primarily for training.

Cmdr Mike Welford, MWSCPD and LCDR Andy Johnstone-Burt were interviewed on the plans for the use of simulation in the MWSC.

Wargaming is a significant element of the MWSC. It's uses include for command training and basic training (esp sonar (generic) simulator, computer aided instruction), officers' command post training, LMCMHQ and communications syndicate groups. Also to be used for tactics development - eg optimal minefield construction - in this case using only one syndicate, no external links. The wargaming tools are also expected to be used for contingency planning.

Also there will be procedural training, eg for Mine Disposal Charge deployment, sweeping, umpiring roles training. It was felt that on-board games are also desirable. The MHC will have its own on-board simulator

It was noted that procedures for wargaming and umpiring need to be defined. MOD is expected to play a role in this.

Phase 3 ($18-20m) is MHC dependent, incorporates what MHC Project will provide - simulators and stimulators. Starts 1994-95. They expect simulators to be installed at the MWSC - ops room and sonar trainers, and integration. These trainers should also be installed on board. Mine Disposal Vehicle trainers will also become available, but these are not part of phase 3.

It was claimed that MOD will definitely be needed for phase 3, to assist with integration problems, and for model development, etc.

Simulation will also be used in the MWSC for operational planning and analysis, for tactics development and for minefield planning.

Though the other Warfare Systems Centres were not visited for this review, it is expected that they all undertake simular roles in terms of training and the use of simulators.

4.7 Naval Warfare Training Centre (Project SEA 1412)

(See also section 4.5.) This is presently managed by LCDR Mike Spruce, from DCFD(Sea). HMAS Watson are trying to have the name of SEA 1412 changed to Maritime Warfare Training Centre, to reflect their desire to have it encompass ADF-wide interests, not just RAN [2].

SEA 1412 has three phases - Phase 1 is worth $1.5m and consists of a Project Definition Study, and is due to commence during FY 1995-96, and last about six months. Phase 2 comprises integration of the FFG and ANZAC Ship simulators with the new IOTTF, is worth $28.5m, and is due for decision during 1996-97, and to complete in 1999. A Phase 3 is planned at this stage, to undertake integration of a number of simulators. The priority order for integration is firstly to include Seahawk, P3C and Collins via a land link, and secondly to provide ships at sea with on-board links, as well as include F/A-18 and F111 simulators.

A draft Defence Force Capability Proposal has been drafted by RANSWARS [2], and will be revised by the Project Office. The modified form is expected to be presented to ACDEV in about February 1994.

LCDR Spruce felt that events might overtake Phase 3, and that by the time it is due to start, the issues may have spread right across the ADF, and a new project may be established to encompass this new focus.

Other aspects of this Project include the following: The Anzac ship simulator which CSA is developing will become available in December 1996. This will also need to be integrated, and there are provisional plans to start developing a DIS protocol on it. The Project Director needs a feasibility study done to examine what phase 3 should comprise, and what is possible. AOD and ITD have both indicated an interest in doing this study (Bob Feik at AOD and Max Possingham at ITD). MOD might be able to help the Project with comments on DIS protocols, and the features and limitations of version 3.0 of the DIS.

LCDR David Stevens, SO Comms at DCFD(Sea) also made a few comments - communications are expected to play a significant role in the Project. He also thought that the OBTS (see section 4.8) may assume some of the requirements currently in SEA 1412.

4.8 On Board Trainer System (Project SEA 1641)

This Project, SEA 1641, is currently sponsored by LCDR Terry Butler within DNMOP (in Canberra). The Project requirement was stated 12 months ago [4], [5], and applies to the FFGs. Project Management is under Rod McMahon from DID. Microwave Radar Division, SRL - REG, Radar Environment Generation - (Gerry Paz?) have funded a feasibility study into the OBTS.

The aim is to get the capabilities of the Combat System Trainer Van onto ships themselves, by miniaturising and improving the technology. Six sensor stimulators are required plus access to the ship's navigation system, as well as a scenario controller. A future development calls for a dedicated data link. Other related Projects include 1412 (section 4.7), 1087 (FFG mil spec model) and 1230 (IOTTF, section 4.5).

Phase 1 of the Project is to cost $2m for a Technology Demonstrator (funded by DID), while phase 2 will cost $15m for the production on six OBTS for FFGs. Phase 1 is

planned for decision in 1994, with delivery and trial and evaluation early 1995. Phase 2 is anticipated to begin in late 1995. Installation is expected to be completed in 1999.

DIS is an enabling technology for the Project, and they have been talking to AOD about it, through NSA. The Project is also seeking guidance on standardisation of the development of the scenario control package. Terry Butler thought that it would be helpful to them if MOD, as well as AOD, started to examine DIS. [This would seem to be adequately treated by AOD, and there is no clear reason for MOD to duplicate that effort.]

The Phase 2 contractor will be responsible for initial operator and maintainer courses, after which responsibility will divert to NTC. Documents giving details were provided [4], [5].

4.9 Anzac Ship

Interviewed CMDR Greg Yorke, Operational Requirements Manager, Anzac Ship Project.

Originally the various aspects of trainers for the Anzac ship were to be dispersed to different places. Now all (Combat Systems Tac Support Facility, Maintenance Training Facility, Platform System Training Centre, etc) are to be located at the Anzac Ship Support Centre (ASSC), Williamstown Development Site (WDS), except for the Combat System Tactical Trainer, which will be at HMAS Watson.

Transfield will own and manage the WDS, at the old Metric Marine Engineering site. It will nevertheless be a naval facility, with emphasis on maintenance training, configuration control, ILS, etc.

The Tactical Trainer at Watson will have full operations room layout. CSA are developing the simulation system for it. It uses a distributed architecture system. SUI's access the LAN - effectively stimulation, but not exactly. [The combat system has a LAN loop (optical fibre) with nodes at various places (SIUs - system interface units(?)). These can be tapped and used to introduce signals to represent inputs from external sensors.]

On board training is supposed to be done by Celsius Tech. A simulation pack in the Combat System. It won't necessarily be too effective and they are not concentrating on it - trying to ensure the Combat System itself is properly developed before worrying about on board training. He felt that the CSA work on the Tactical Trainer could also be used on board - just add a few simulation workstations for instructor's consoles.

He likes MRad[2] (Adelaide) radar stimulation. What the Project is doing for the Anzac is good, but this is not as good as MRad. Later they would like to consider linking ships and shore simulators. They have been asked to make the trainer

[2]See the article in DSTO OnLine No 12, October 1993 for some information on MRad.

compatible with DIS - but need to know more about what DIS is, also are reluctant to increase costs at this stage. So it does not conform to the DIS protocols.

Test sites already exist at sites around Australia and Sweden (Celsius Tech) - consoles - Navy has access to them and MOD was invited to view them when convenient. The Adelaide Test Site has a full set of consoles, interfaces, etc - and will have an entire system there, eventually. WDS is also well down the track - it already has much of the supporting equipment. The plan is by March 94 to have the ops room completed at WDS. They will only use emulation for sonar and ESM (not simulation).

Transfield are responsible for training the first two crews. They are also using the WDS to test/prove the equipment.

There are no plans for landline links in the project.

They anticipate a crisis point at about year 2000 - second crews will be needed for the first ship, ship 4 will be ready, (4 years after 1st launch). This will cause problems as they won't have facilities to train everyone they want to train. At the peak they will have about 500 needing training. On board training may help solve the problem.

CSA are well advanced with the simulation program. Getting simulation on board, as opposed to the shore based trainer, may get a higher priority once their designs are completed.

CMDR Yorke saw little need for MOD assistance at present - but may later need MOD - eg to advise on compatibility of simulator trainers and use of DIS - to enable the Anzac trainer to talk to the IOTTF (Compucat developing). CSA believe that incorporation of the Anzac simulator into DIS is possible.

He would like to eventually be able to sit alongside and link into HMAS Watson and undertake command team training in-ship.

They already task - M. Battaglia on Anzac radars, and GWD on Sea Sparrow - performance assessment.

Their (PD) representative at Williamstown is CMDR Pat Williams.

4.10 Military Strategy and Concepts, HQADF

DGMSC have produced a discussion paper on simulation, as a first step towards producing an ADF policy on the subject. The discussion paper was produced by Major Tony Maple It is not currently widely distributed. The Scientific Advisers have been asked to provide comments on it, prior to revision and wider dissemination. The copy of the paper which was provided to NSA was examined [25]. It was also discussed with WGCDR Stefan Jerga, DDAC, in the company of NSA and AFSA.

Major Maple's draft discussion paper seems to be influenced primarily by RAAF interests, at this stage. NSA was not involved in its formulation (nor was AFSA), though it has been provided to the Scientific Advisers for their comment prior to wider release.

The interest in simulation as presented in the discussion paper, is general, though the discussion paper arose from approaches by Max Possingham seeking guidance on ADF needs for simulation in joint service command and control.

It was felt that DFCPs need more analysis to support them, and that simulation is one tool for providing this. It is also useful for operational concepts and capability analysis studies. There is also a need for a more Australian approach, catering for our own situations and environments.

Mention was made of work done for them by Keith Linnard at ADFA, and Peter Clark (now at AOD) and his connection with the UTP-2 action group on virtual reality.

DGMSC are also producing a list of technology priorities in the area of simulation. They expect that an ADF-wide steering committee on simulation will be established and that this list will become one of that committee's responsibilities. NSA suggested that the committee should be chaired by the Senior Defence Scientific Adviser.

4.11 NSA Review

NSA and ANSA have studied this area in detail. They are working to develop an overall policy for CNS on Navy use of simulation. Many of the interviews from which this present report grew, were held with these people present.

NSA's study of simulation has been to some extent overtaken by events. This is particularly the result of the work that DGMSC has undertaken (section 4.10, above). NSA is, however, still working on those aspects which are of unique interest to Navy. As noted elsewhere, the RAN is less interested in high fidelity and human factors-based simulators than they are in basic and team trainers, and this places a somewhat different emphasis on their approach to simulation than is the case for the RAAF, at least.

5. Overseas Trends

Simulation is recognised by many other nations as a means for undertaking effective initial and expert training while minimising the costs of training. As such, there is a strong initiative currently underway in, for example, the United States and the UK, to develop simulators and simulation techniques for training and a range of other purposes. Australia can benefit from these moves by gaining access to the new developments through DEAs, MOUs and TTCP agreements with these nations. It

would be costly and futile for Australia to attempt to develop simulation technology in isolation from these significant players.

Perhaps the single most important development in simulation overseas is the US Army initiated Distributed Interactive Simulation system [7], [15], [24]. "The primary mission of the DIS is to create synthetic, virtual representations of warfare environments by systematically connecting separate subcomponents of simulation which reside at distributed, multiple locations."[7]. RANSWARS are particularly interested in the DIS concept, for enhancing their team training capabilities, and to encourage greater use of simulation for training on board ships alongside or at sea. Admiral Kelso, USN Chief of Naval Operations, appears to be a strong proponent of the use of both simulation for training per se, and for the introduction of DIS into training [7], [20], [24]. The US DoD has established a Defense Modelling and Simulation Master Plan [23], reflecting a large investment by the US in the area.

As well as the DIS system, a wide range of individual simulators for many applications are being developed overseas. This includes gunnery simulators and many others which may be of interest to NTC. Simulation is being increasingly used for much more than training, however. For example, the US Army has a strong push to make more use of simulation in the acquisition process to "design, develop, and test emerging technologies through rapid prototyping"[15].

In the UK, it has recently been recognised that greater use of simulation will be necessary in future [22]. Many simulations of potential value to the RAN are thought to be in development, and a watch on the effort in the UK is recommended.

A TTCP-based Ad Hoc Study Group (AHSG) on Simulation and Virtual Reality has been established [23] as a result of NAMRAD '92, and has met several times, with the UK Washington Deputy, Dr Michael Rance as the Cognisant Deputy. The Chairman is J. Thomas Warfield of the Office of Naval Research, who has interests in distributed simulation and mine countermeasures. Dr D. Sinnott, CITD attended the first meeting of the Group in September 1993, while in the USA. The papers from this meeting are being forwarded to CMOD. It is indicated that in future, Dr Lough (CAOD) will represent Australia at this Group. A second meeting was held in early December 1993, also in the USA, at short notice.

It would be worthwhile for MOD to monitor the activities of the Ad Hoc Study Group, in order to keep abreast, particularly of US and UK, activities on simulation. At times, MOD may also require representation at the Group, for specific functions.

6. Recommendations for MOD

MOD has undertaken simulation work for many years, though the Division has never been involved in the hardware or systems aspects. Since these are typically well understood by Australian industry (or foreign companies in Australia), there is no

justifiable reason for MOD to begin working on these aspects. AOD at ARL have an established capability in the design of simulation systems, and are developing an understanding of interactive (DIS-like) simulators, and they should retain the expertise in this area, provided they are willing to accept tasking in this area from all three Services (and the PolCom area).

It is pointless for MOD to duplicate capabilities which exist in industry and AOD. There may be times when the RAN seeks advice from MOD in these areas, and in these circumstances, it may sometimes be desirable for MOD to act as a broker between the RAN and other providers of the information or service. That would seem to be the extent of the requirement that MOD should meet in the area of simulation hardware and systems.

The area of MOD strength covers the analysis and development of tactical models and algorithms, of performance modelling and of modelling the effects of the environment on Naval activities. Where these are required for the development of a simulator, there is no doubt that MOD should provide that service. In addition, MOD has in the past provided the RAN with analysis of its performance in a range of areas, and this expertise could be used to assist Navy to develop a more analytic approach to its use of simulations and to develop new and more effective applications of simulation. MOD is also in a position to provide Navy with an assessment of the effectiveness with which it makes use of simulations.

Much of the latter capability resides within the Operations Research Thrust at the Pyrmont site, and it might be expected that those personnel would at times be required to provide this form of assistance. In the mine warfare area, the operations research and algorithm development work takes place primarily in the Mine Warfare Operations Thrust, and this area will also be required to contribute, where appropriate.

In addition, a wide range of skills exist in sonar technologies, both at Pyrmont and Salisbury, and these should be called on for their assistance in simulation developments, as appropriate. For example, the specification of a mine hunting sonar simulator to be installed in the MWSC, as part of phase 3 of the project, could require detailed advice from personnel at Pyrmont. The subsequent verification and validation of the simulator might also involve these personnel, and further design improvements may also be requested from MOD.

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8. Bibliography

1 Force Development (Sea) Organisation Chart

2 Defence Force Capability Proposal, 1412, Maritime Warfare Training Centre (DRAFT)

3 A Profile of Training Simulators at the RAN Surface Warfare School and Proposals for Simulator Integration, L.W. Goodridge

4 Project 1641, On Board Trainer System (OBTS), Minor Item Submission, Issue 1, 4 Feb 1993

5 RAN Onboard Training Equipment Developments, N92/22552, DNW 648/92, M.C. Smith, DNW

6 A New Simulation Facility for Research in Military Air Operations, R.A. Feik and W.M. Mason

7 Distributed Interactive Simulation, Operational Concept, March 1993, IST-TR-93-10, draft 2.2

8 Naval Training Command Organisation Chart, 18 June 1993

9 Naval Training Command, Strategic Plan 1993/97

10 Air Operations Simulation Centre, Report to CDS, R. Lough, CAOD, Sept 1993

11 The Use of Simulators to Improve Air Operations and Acquisitions in Australia, R.A. Feik & W.M. Mason, SITRA 93, Bandung, Indonesia, July 1993

12 P3C data Management System Simulation Overview, P.R. Temple et al, GWD Report, July 1993

13 Overseas Visit Report - J.G. Schapel - September 1993, ITD November 1993

14 CBT: The Cost Effective Training Aid, B. Walters, Asian Defence Journal 7, p26, 1993

15 Army Enterprise Strategy: The Vision, US Army, 1993 (270/202/0001, fol 67)

16 Simulation Technology Making Rapid Advances, A.C. Cruce, Defense Electronics, March 1993

17 Simulation Potential Rife But Confusion is Problem, J. Loube, National Defense, July/August 1993

18 Special Issue on Simulation, Safety at Sea, September 1993

19 CONDS(W) Report of 16/9/93, Advanced Distribution Simulation Offers Great Opportunity, and USAF Wants Industry to Ride M&S Bandwagon

20 Kelso Urges Training, Navy News & Undersea Technology, 30 Aug 1993

21 CONDS(W) Report of 31/8/93, Battle Labs (US Army Materiel Command)

22 CONDS(L) Report September 1993, Comments by the UK Secretary of State for Defence

23 CONDS(W) Report of 24/11/93, Ad Hoc Study Group on Simulation, and Defense Modelling and Simulation Initiative, and telecons with D. Sinnott

24 Proceedings of the 5th Australian Aeronautical Conference 1993, Fundamentals of Modern Simulation Workshop, 16-17 September 1993, Melbourne

25 Discussion Paper on ADF Requirements for Simulation and Wargaming, DGMSC, DEV 93-25163, October 1993.

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20. ABSTRACT

A review was undertaken of the needs within the Royal Australian Navy for simulation and simulators. These are being used increasingly for a wide variety of purposes, or are being considered for use. A summary of the interest within Navy on the subject is presented. In addition, an assessment has been made of those aspects in which Maritime Operations Division could provide a contribution, either through assessment, modification, or development of simulations. A list of recommendations for the way ahead for MOD activities in this area is provided.

Use of Simulation in Maritime Operations and Training

D.D. Richardson

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